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Long-term dynamics of phytoplankton assemblages: *Microcystis*-domination in Lake Taihu, a large shallow lake in China

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Long-term phytoplankton assemblages in a large shallow Chinese lake, Lake Taihu, were presented using the monthly monitoring data from October 1991 to December 1999. Earlier research results (1960, 1981 and 1988) were applied to discuss the different trophic stages of the lake. The species composition in the lake was more closely related to eutrophication level than to lake-size, shallowness, or turbidity. Each summer, a single peak of phytoplankton biovolume appeared in Meiliang Bay. The results of principal components analysis showed a distinct temporal shift in species composition between summer and winter. A clear spatial difference in phytoplankton occurred between Meiliang Bay and the lake centre. Wind speed and direction affected the horizontal distribution of phytoplankton, especially Microcystis, in the lake. Temperature, underwater light climate, nutrients and grazing by zooplankton and by fish were discussed to explain the overwhelming dominance of Microcystis. Four nutrient-phytoplankton stages were identified in the lake: an oligo-mesotrophic stage with low algal biomass until 1981, a eutrophic situation with blooms of Microcystis during 1988–1995, hypertrophic conditions with the dominance of Planctonema and total phosphorus up to 200 mg m^{-3} from 1996 to 1997 and the restoration period after 1997. The wax and wane of the phytoplankton assemblages were mainly controlled by temperature, wind and turbidity while long-term biomass dynamics were influenced by the level of nutrients.

INTRODUCTION

China has a large number of freshwater ecosystems. Nevertheless, freshwater resources of good quality are not abundant and hence water availability per capita is only a quarter of the worlds average (Dokulil *et al.*, 2000). Historically, human populations in China have always lived close to lakes, which recently has resulted in increased water consumption and, as a consequence, water pollution and water shortage. Many of Chinas lakes are shallow, situated in the densely populated lowlands and are used for drinking and irrigation among several other purposes.

World-wide, shallow water ecosystems are much more numerous than deep lakes and hence are of great importance. Such shallow systems usually have specific characteristics influencing their management. About 35 lakes are situated between 22.5° and 35° latitude north and south of the equator, with surface areas larger than 500 km^2. This number includes 20 saline or brackish waters and 15 freshwater lakes, of which five are located on the Qinghai–Tibet–Altiplano at elevations higher than 4000 m (Herdendorf, 1990). From the remaining ten lakes, seven (including Lake Taihu) are located in central-east China which is the region of fastest development. All are shallow with mean depths less than 10 m (Chang, 1987). Most of them are used as sources of drinking water, although they are eutrophic because of nutrient overdose and therefore have become cyanobacteria-dominated ecosystems.

The large shallow lake, Taihu, located in the vicinity of two large cities and about 100 km west of Shanghai, which is the biggest city in China, is a good example because of its multiple uses, among which drinking water abstraction, wastewater discharge and fisheries are the most important. Irregular observations in the lake are available from the years 1960, 1981 and 1988 (Sun and Huang, 1993). Eutrophication as a result of enhanced nutrient input from the catchment began in the 1980s (Shi and Zai, 1994). Studies of the trophic relations and